

Our Docket No.: 42P13296D

**RESPONSE UNDER 37 C.F.R. § 1.116**  
**-- EXPEDITED PROCEDURE --**  
**EXAMINING GROUP 2800**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Kozhukh

Application No.: 10/648,950

Filed: August 26, 2003

For: Interconnect Structures in  
Semiconductor Device and Processes of  
Formation

) Examiner: Yevsikov, Victor V.

) Art Group: 2891

**RESPONSE AFTER FINAL**

Mail Stop: AF  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In response to the Final Office Action mailed on August 30, 2005, which was made final, applicant submits this Amendment After Final Action for consideration.

**FIRST CLASS CERTIFICATE OF MAILING/FACSIMILE**

I hereby certify that I am causing the above-referenced correspondence to be facsimile transmitted and to be deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and that this paper or fee has been addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

October 27, 2005

Date of Deposit

Leah Schwenke

Name of Person Mailing Correspondence

*Leah Schwenke*

Signature

October 27, 2005

Date

Docket No.: 42P13296D  
Application No.: 10/648,950

**In the specification:**

Please replace paragraph [0025] with the following amended paragraph:

[0025] The particular combination of metal layers and processing steps described in the foregoing embodiment results in the formation of a silver interconnect which may be utilized in a variety of integrated circuit structures. One example of the utilization of the silver interconnect structure and process of the invention is illustrated in FIG. 7. Referring to FIG. 7, after transistor 140 and field isolation regions 132 have been formed, an interlevel dielectric layer 160 is formed overlying transistor 140 and field isolation regions 132. In one embodiment, interlevel dielectric layer 160 comprises dielectric layer 142, etch stop layer 144 and dielectric layer 146.

Please replace paragraph [0028] with the following amended paragraph:

[0028] A portion of dielectric layer 146 and a portion of etch stop layer 144 are then removed to expose a portion of via plugs 152 and form interconnect opening. Interface layer 158 is formed in accordance with the previously described processing steps and directly overlies the exposed portion of via plugs 152. A silver interconnect 154 is then formed in accordance with the previously described processing steps. Via plugs 152 enables a subsequently deposited conductive layer 156 to be electrically coupled to source/drain regions 134 of the transistor 140 through silver interconnect 154 and interface layer 158. It would be appreciated that the foregoing process steps may be repeated in order to fabricate additional levels of conductive interconnects.

Please replace paragraph [0040] with the following amended paragraph:

[0040] During the UV lithography process, a photoresist mask 210 is placed directly on the surface of silver layer 206 without an antireflective coating, as illustrated in FIG. 12. The photoresist mask 210 is then exposed to UV light. As a result, the chemical structure of some of the photoresist mask 210 materials are changed. After a developing process, only a portion of the mask 210 that covers the interconnect is remained. Other lithography process may be employed.

Please replace paragraph [0042] with the following amended paragraph:

[0042] After the interconnect 218 is formed, a protection layer 212 is deposited overlying the silver layer 206 and the interface layer 216, as illustrated in FIG. 16. The protection layer 212 is formed to prevent silver layer 206 from diffusion into other materials, such as dielectric layer 214 of FIG. 18. In one embodiment, protection layer 212 ~~protection layer 214~~ may be a layer of titanium. In an alternative embodiment, protection layer 212 ~~protection layer 214~~ may be a layer of titanium nitride or tantalum nitride. In a further alternative embodiment, the protection layer may be a layer of tungsten. Other materials that prevent silver diffusion may be utilized as a protection layer.

**In the claims:**

For the Examiner's convenience, all pending claims are presented below with changes shown in accordance with the mandatory amendment format

1. (Previously Presented) A process, comprising:  
providing a device substrate having a dielectric layer thereon;  
removing a portion of the dielectric layer to create an opening;  
forming an interface layer within the opening;  
forming a silver layer overlying the interface layer;  
annealing the substrate to form an intermetallic layer between the silver layer and the interface layer, in which the silver layer is in intimate contact with the intermetallic layer; and  
forming a protection layer overlying the silver layer which is thick enough to prevent the silver layer from diffusing into other materials.
2. (Original) The process of claim 1, further comprising removing portion of the silver layer, intermetallic layer, and the interface layer overlying the dielectric layer to form a smooth surface.
3. (Original) The process of claim 1, wherein the interface layer comprises an adhesion layer and a diffusion barrier layer overlying the adhesion layer.
4. (Original) The process of claim 3, wherein the diffusion barrier layer comprises titanium nitride or tantalum nitride.

5. (Original) The process of claim 3, wherein the adhesion layer comprises titanium, tungsten, aluminum, or titanium nitride.
6. (Original) The process of claim 1, wherein the interface layer is formed using sputter deposition process.
7. (Original) The process of claim 1, wherein the silver layer is formed using sputter deposition process.
8. (Original) The process of claim 1, wherein the substrate is annealed at an ambient temperature of approximate 400 degree Celsius for a period of approximate one hour.
9. (Original) The process of claim 2, wherein the removing comprises a chemical-mechanical-polishing (CMP) process.

10-23. (Cancelled)

24. (Previously Presented) An interconnect structure, comprising:
  - a device substrate;
  - an interface layer overlying the device substrate;
  - a silver layer overlying the interface layer;
  - a protection layer overlying the silver layer which is thick enough to prevent the silver layer from diffusing into other materials; and

a dielectric layer overlying the protection layer.

25. (Original) The interconnect structure of claim 24, wherein the interface layer comprises an adhesion layer and a diffusion barrier layer overlying the adhesion layer.

26. (Original) The interconnect structure of claim 25, wherein the diffusion barrier layer comprises titanium nitride or tantalum nitride, and wherein the adhesion layer comprises titanium, titanium nitride, aluminum, or tungsten.

27. (Original) The interconnect structure of claim 24, wherein the protection layer comprises titanium, titanium nitride, or tungsten.

28. (Previously Presented) An interconnect structure, comprising:

- a device substrate;
- a dielectric layer overlying the device substrate, the dielectric layer having a cavity therein;
- an interface layer overlying the dielectric layer, the interface layer having a thickness insufficient to completely fill the cavity;
- a silver layer overlying the interface layer, the silver layer having a thickness sufficient to completely fill the cavity; and
- a protection layer overlying the silver layer which is thick enough to prevent the silver layer from diffusing into other materials.

29. (Original) The interconnect structure of claim 28, wherein the interface layer comprises an adhesion layer and a diffusion barrier layer overlying the adhesion layer.

30. (Original) The interconnect structure of claim 29, wherein the diffusion barrier layer comprises titanium nitride or tantalum nitride, and wherein the adhesion layer comprises titanium, titanium nitride, aluminum, or tungsten.



## **Remarks**

Applicant respectfully requests reconsideration of this application as amended. The specification has been amended. No claims have been amended, cancelled, or added. Therefore, claims 1-9 and 24-30 are presented for examination.

### **35 U.S.C. §112 Rejection**

Claims 1, 24 and 28 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement.

More specifically, the Office Action asserts that the applicant added a limitation to a protection layer that has no support in the specification. The Office Action states “[t]he claims are drawn to embodiments described in figs. 1-7. However, the specification does not set forth any protection layer in relation to these first two embodiments – only in relation to the third embodiment of figs. 13-19, that are directed to the non-damascene wiring layer.” (Final Office Action mailed 8/30/05 at pg. 2.)

Firstly, the Office Action asserts that the embodiments of figures 13-19 are directed to a “non-damascene wiring layer”. Applicant assumes that the term “non-damascene” is referring to a non-etched or non-inlaid silver interconnect structure. Applicant respectfully asserts that nowhere in the present application are the embodiments relating to figures 13-19 referenced or referred to as a “non-damascene wiring layers”. Applicant has not limited these embodiments to that particular description.

Secondly, applicant submits that the protection layer feature added to claims 1, 24, and 28 does have support in the specification. Although, the description of the

protection layer was described in relation to figures 8-19 of the present application, the application does state:

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will be evident that **various modifications may be made thereto without departing from the broader spirit and scope of the invention** as set forth in the following claims. The specification and drawings are, accordingly, to be **regarded in an illustrative sense rather than a restrictive sense**.

Specification at page 17, paragraph [0049] (emphasis added).

Referring to page 15, paragraph [0042], line 2, of the present application, it is disclosed that a protection layer is formed *to prevent a silver layer from diffusing into other materials*. Claim 1 also provides that the protection layer is provided to prevent a silver layer from diffusing into other materials. Accordingly, applying a protection layer over the silver layer of figures 1-7 serves the purpose of preventing silver layer 110 from diffusing into other materials (such as the conductive layer 156), similar to preventing silver layer 206 from diffusing into other materials (such as dielectric layer 214).

As it was provided in the present application that the particular embodiments of the invention may have modifications made thereto and that the specification and drawings are to be regarded in an illustrative rather than restrictive sense, it follows that applying a protection layer overlying the silver layer 110 provided with respect to figures 1-7 would be supported claim subject matter for the present application. The feature of protection layer should not be solely limited to the specific embodiment provided by figures 8-19, as this was not contemplated by language of the present application. Therefore, applicant respectfully submits that the claims of the present application are allowable.

### **Specification**

The specification is objected to because in Figure 7, numeral 156 is not described in the specification. The specification has been amended to correct this omission.

The specification is objected to because at page 15, paragraph [0042], line 4, the words “protection layer 214” should refer to numeral 212. The specification has been amended to correct this error.

The specification is objected to because at page 15, paragraph [0042], line 5, the words “protection layer 214” should refer to numeral 212. The specification has been amended to correct this error.

Therefore, applicant respectfully requests that the objections to the specification be withdrawn.

### **Drawings**

The drawings are objected to as failing to comply with 37 CFR §1.84(p)(5) because they include the following reference character(s) not mentioned in the description: layer 156, fig. 7. The specification has been amended to refer to this reference character. Therefore, applicant respectfully requests that the objections to the drawings be withdrawn.

Applicant respectfully submits that the rejections have been overcome and that the claims are in condition for allowance. Accordingly, applicant respectfully requests the rejections be withdrawn and the claims be allowed.

The Examiner is requested to call the undersigned at (303) 740-1980 if there remains any issue with allowance of the case.

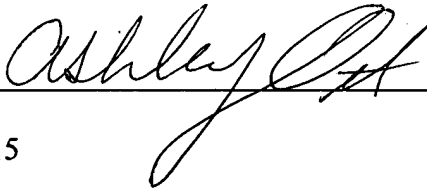
Applicant respectfully petitions for an extension of time to respond to the outstanding Office Action pursuant to 37 C.F.R. § 1.136(a) should one be necessary. Please charge our Deposit Account No. 02-2666 to cover the necessary fee under 37 C.F.R. § 1.17(a) for such an extension.

Please charge any shortage to our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: October 27, 2005

  
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